NEW CARBAZOLE BASED HOST MATERIALS FOR THERMALLY ACTIVATED DELAYED FLUORESCENT OLEDS

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D.Blazevicius[1], R.Beresneviciute[1], M.Eidimtas[1], G.Krucaite[1], S.Grigalevicius[1], S.S.Swyamprbha[2], K.K.Kesevan[2], I.Siddiqui[2], M.R.Nagar[2], R.A.K.Yadav[2], J.-W. Jou[2].

[1]Department of Polymer Chemistry and Technology, Kaunas University of Technology, Radvilenu plentas 19, LT50254, Kaunas, Lithuania.
[2]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan.

Introduction

Several functional and internal layers have been used to improve the performance of solution-processed OLED devices. In the case of thermally activated delayed fluorescence (TADF) OLEDs, a large number of emitter materials have already reported, but the design and development of potential host materials are overlooked. Efficient solution processable host materials for TADF OLEDs can reduce the complexity in the device architecture and production cost. We utilized a series of carbazole based solution-processable host materials to fabricate the 2,4,5,6-tetra(9H-carbazol-9-yl)isophthalonitrile (4CzIPN) based green TADF OLEDs. The resultant device exhibits a maximum power efficiency of 20.8 lm/W, current efficiency of 33.1 cd/A, and external quantum efficiency of 13.7% with a maximum luminance of 2,176 cd/m2. The excellent performance may attribute to the low singlet-triplet energy gap (ΔEST), high photoluminescence quantum yield (PLQY), high thermal stability, and unique porous morphology of the materials.

Chemical structure

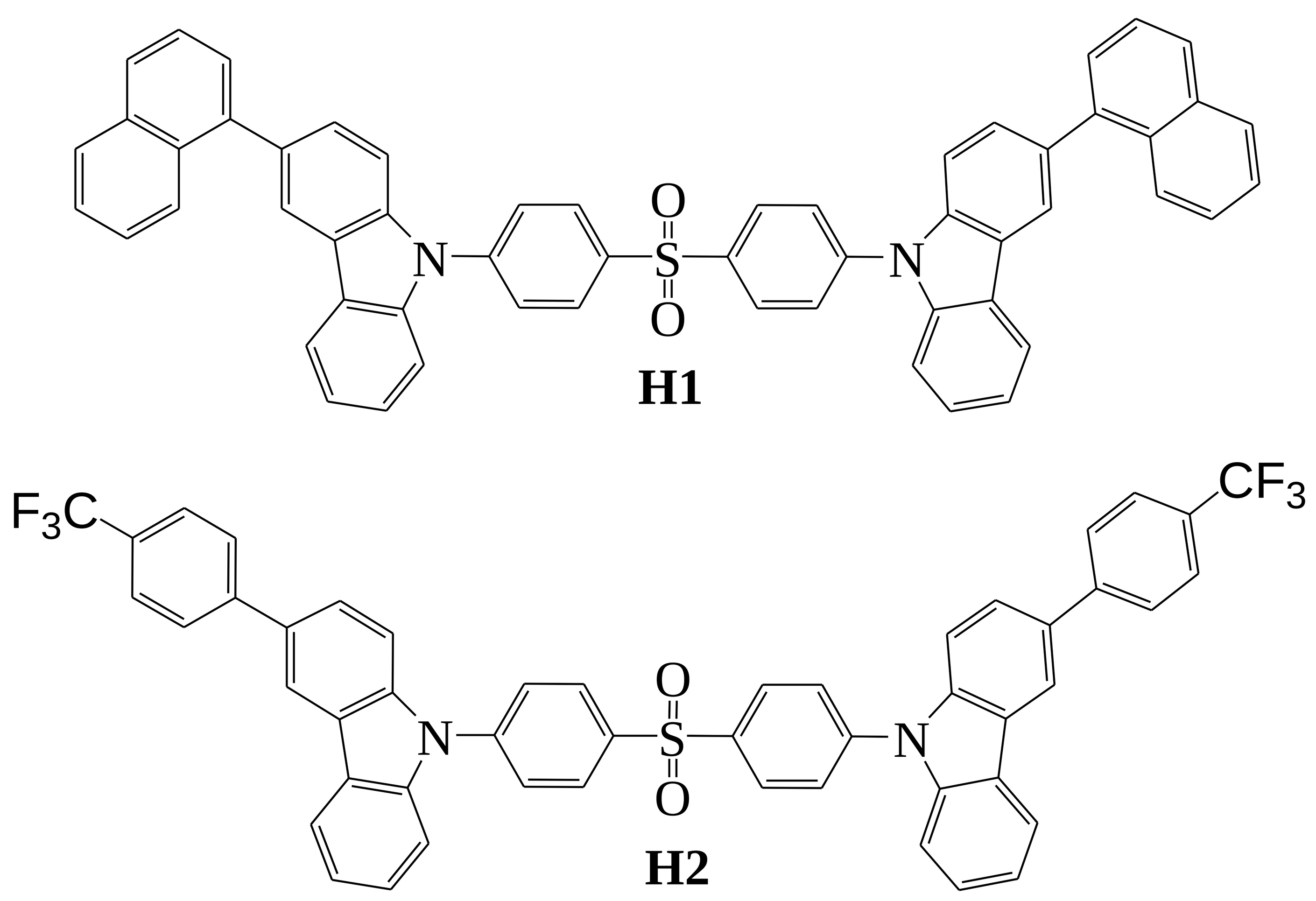

FIGURE 1. *Chemical structure of carbazole – based materials*

Thermal properties

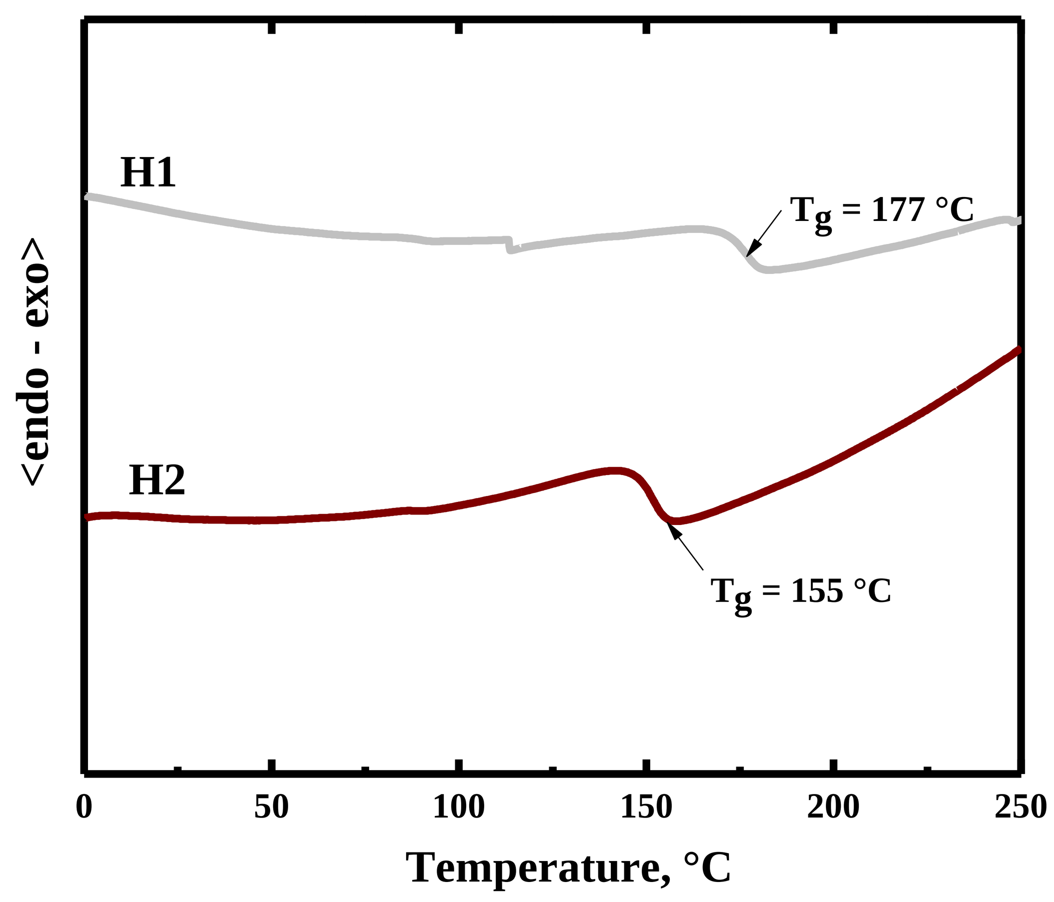

FIGURE 2. *DSC curves of carbazole – based materials*

Electrochemical and photophysical properties

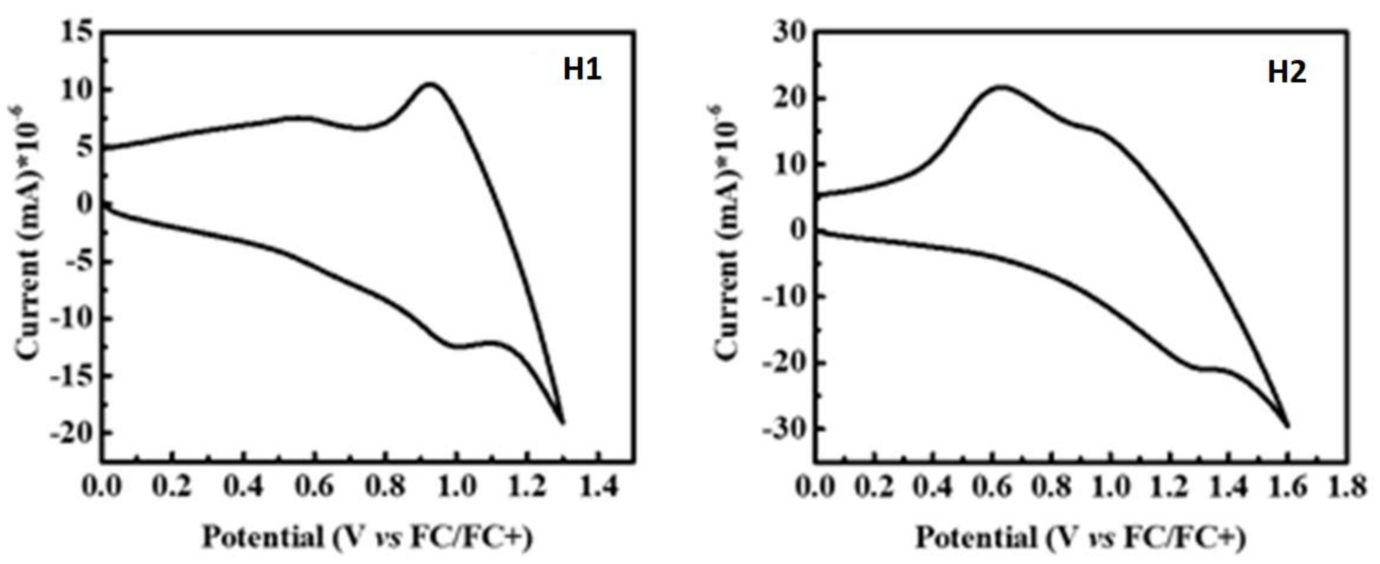

FIGURE 3. *Cyclic voltammetric scans of the host materials **H1** and **H2***

Compound	HOMO	LUMO	E_T
H1	-5,76 eV	-2,40 eV	2.57 eV
H2	-5,71 eV	-2,57 eV	2.88 eV

TABLE 1. Electrochemical properties of objective compounds

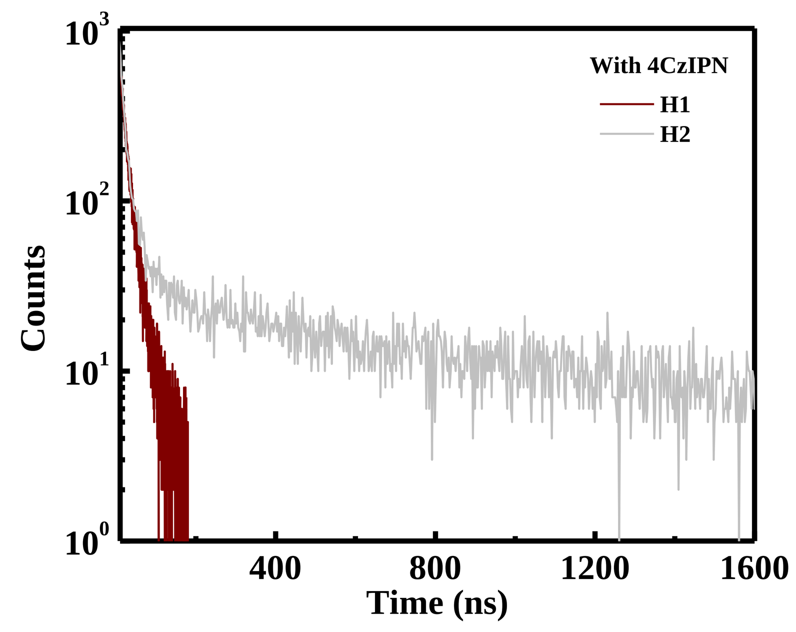

FIGURE 4. Transient PL decay curves of novel host materials with TADF emitter, 4CzIPN

OLED characterisation

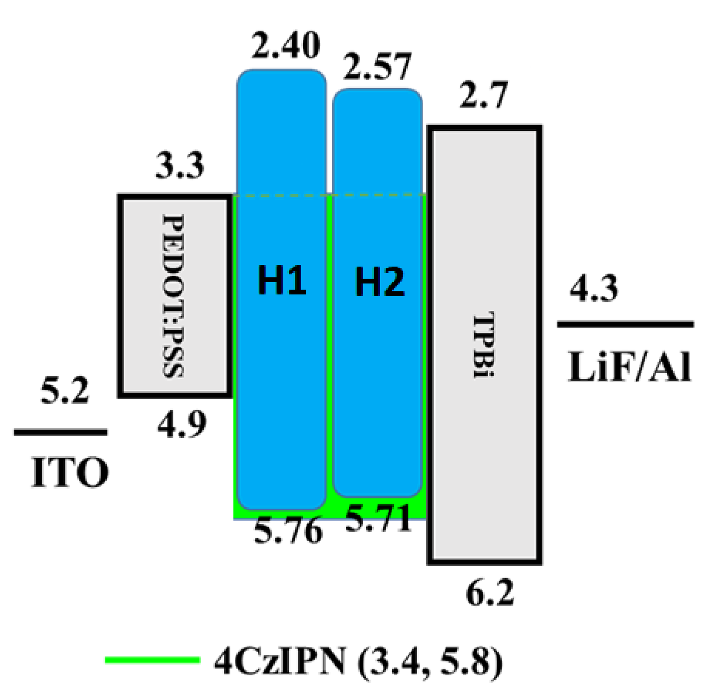

FIGURE 5. *Schematic energy level diagram of TADF OLED devices utilizing novel host materials*

Host	Dopant (wt%)	ON (V_{on})	$PE_{100}/CE_{100}/EQE_{100}$ ($lmW^{-1}/cdA^{-1}/\%$)	$PE_{1000}/CE_{1000}/EQE_{1000}$ ($lmW^{-1}/cdA^{-1}/\%$)	$PE_{max}/CE_{max}/EQE_{max}$ ($lmW^{-1}/cdA^{-1}/\%$)	CIE_{xy} Coordinates (@100/@1000 cd/m^2)	Max. Lum (cd/m^2)
H1	5	4.0	3.4/5.1/1.6	2.1/4.2/1.4	3.4/5.1/1.6	(0.28, 0.56)/(0.26, 0.53)	2166
	10	3.9	9.8/12.6/3.9	6.8/10.8/3.0	14.0/15.6/4.6	(0.34, 0.58)/(0.32, 0.57)	3925
	15	3.5	10.3/13.2/3.9	5.4/8.2/2.5	10.3/14.7/3.9	(0.32, 0.58)/(0.30/0.57)	3423
H2	5	5.3	7.8/15.0/5.0	4.2/10.1/-	8.1/15.8/5.3	(0.27, 0.56)/-	1525
	10	4.3	13.7/21.7/9.0	9.3/17.9/4.8	20.8/33.1/13.7	(0.29, 0.58)/(0.29, 0.57)	2176
	15	3.7	5.0/7.0/2.5	8.6/14.5/3.8	9.0/14.5/3.9	(0.30, 0.59)/(0.29, 0.58)	2823

TABLE 2. EL characteristics of the green TADF OLEDs fabricated using newly synthesized hosts **H1** and **H2**

Conclusion

Solution processable high-triplet energy carbazole derivatives, 9,9'-(sulfonylbis(4,1-phenylene))bis(3-(naphthalen-1-yl)-9H-carbazole) (**H1**) and 9,9'-(sulfonylbis(4,1-phenylene))bis(3-(4-(trifluoromethyl)phenyl)-9H-carbazole) (**H2**) have been used as host matrix to fabricate the 2,4,5,6-Tetra(9H-carbazol-9-yl)isophthalonitrile (4CzIPN) based green TADF OLEDs. Among the two materials, **H2** showed better performance in the device compared to other devices. The resultant device exhibits a maximum power efficiency of 20.8 lm/W, current efficiency of 33.1 cd/A, external quantum efficiency of 13.7%, and maximum luminance of 2,176 cd/m2. The better performance of **H2** may be attributed to not only the high triplet energy and low ΔEST value but also the unique porous morphology of the host material, which may improve the carrier mobility and surface to volume ratio of EML and HTL and facilitate the electron transport. The higher PLQY (81.34± 2%) value of **H2** with 4CzIPN also played a crucial role in the better performance of **H2**.

Acknowledgements
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